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EVERY FORTNIGHT

QUEST

ADVENTURES IN THE WORLD OF SCIENCE

LIGHT AND IMAGES 16

GIANT **POSTER:**
GHOST PICTURES

PLUS

MODEL: ZOETROPE

THREE **PROJECTS**

FACT FILES ON:

- *The light spectrum*
- *Infra-red 'sight'*
- *Big screen cinema*
- *Lasers – killer rays*
- *Optical illusions*
- *Beyond visible light*
- *Multi-faceted eyes*

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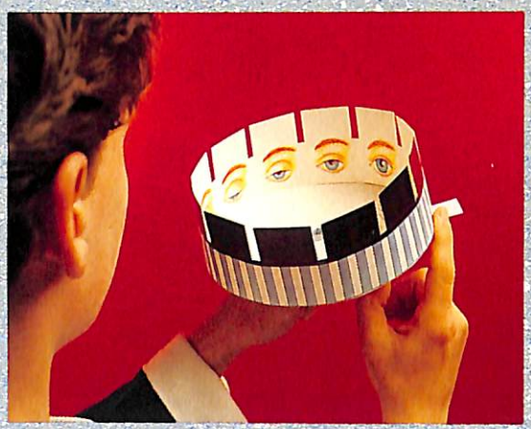
INSIDE THIS PACK

FACT FILES

▶ Bouncing Light ▶ Latest Space 'scopes ▶ Mirror images ▶ Microfilm ▶ Lasers ▶ Cinema projectors ▶ The 'optical window'



POSTER

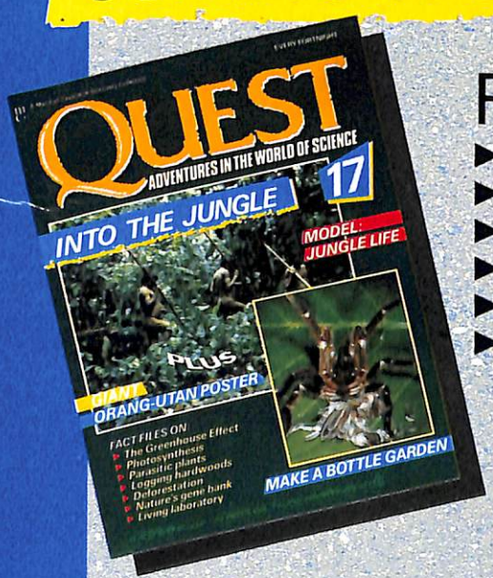
How holograms are made

MODEL Zoetrope

PROJECT SHEET

- Take a 3-D picture
- Make a pin-hole camera
- Split sunlight into a spectrum

COMING IN QUEST 17 INTO THE JUNGLE



FACT FILES INCLUDE:

- ▶ The Greenhouse Effect
- ▶ Carnivorous plants
- ▶ A living laboratory
- ▶ Photosynthesis
- ▶ Parasites
- ▶ Logging and farming

POSTER Orang-utan: Old man of the forest

Jungle life

MODEL

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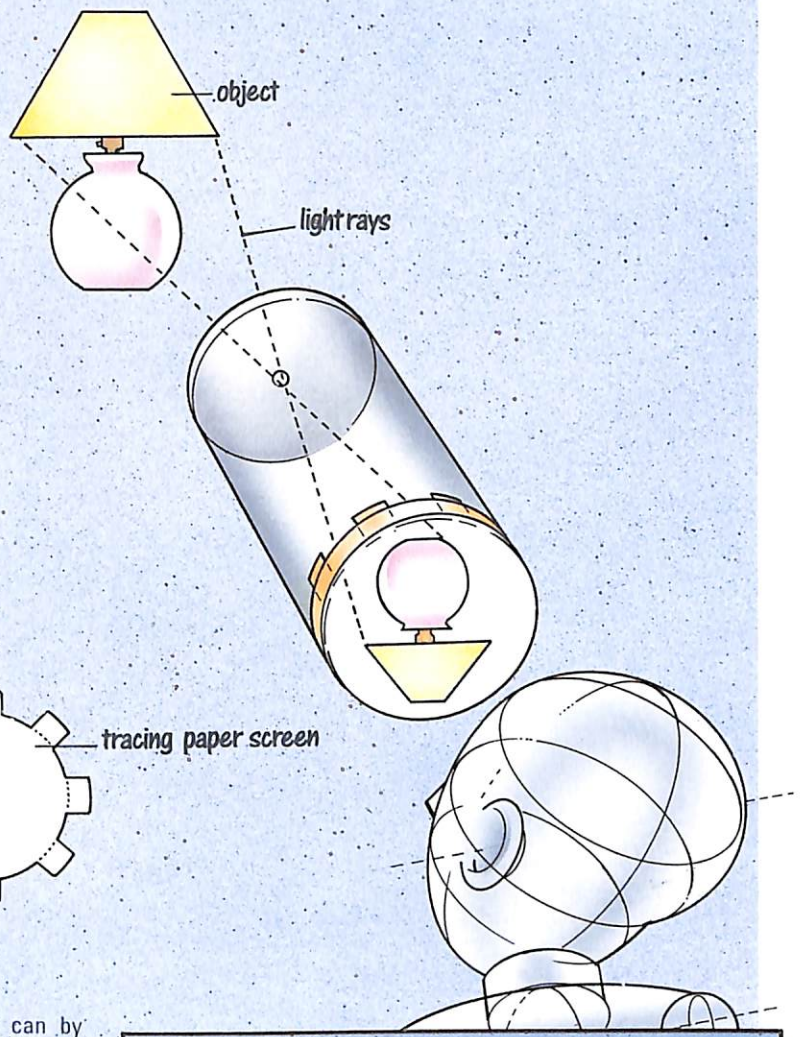
PROJECTS
LIGHT

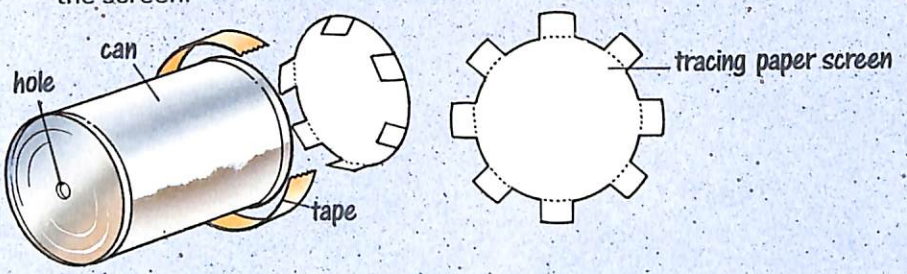
- How can you demonstrate the principle of the camera using a tin can and a piece of paper?
- How can you take and view stereo (3-D) photographs?
- How can you split sunlight into the colours of the rainbow?



PINHOLE CAMERA

1 2 3 4 5

You can make a pinhole camera using a tin can, a piece of tracing paper, some sticky tape, a hammer and a nail and use it to form images on a screen. Cameras like this were once used to take photographs by putting a light-sensitive plate in place of the screen.



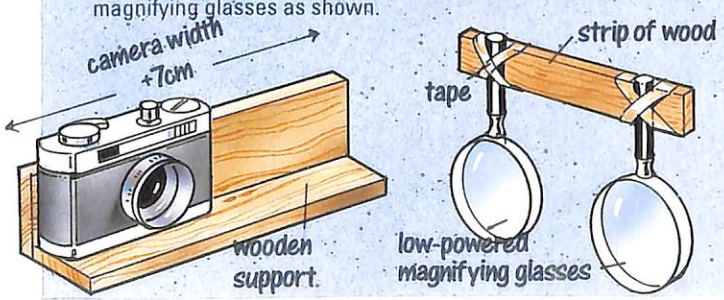
Make a hole in the bottom of a clean, empty tin can by hammering a small nail – about 1mm wide – through it. Trace the end of the can on to a sheet of tracing paper and cut it out as shown. Finally, tape the screen of paper to the open end of the can. When pointed at a bright object, such as a table lamp, the camera will show an upside-down image, in natural colour, but smaller than life, on the screen. To make the image clearer and brighter you should shut out unwanted light by laying a blanket or jacket over your head and the back end of the tin. Alternatively, fashion a shield from a roll of dark card.

TAKING 3-D PHOTOGRAPHS

1 2 3 4 5

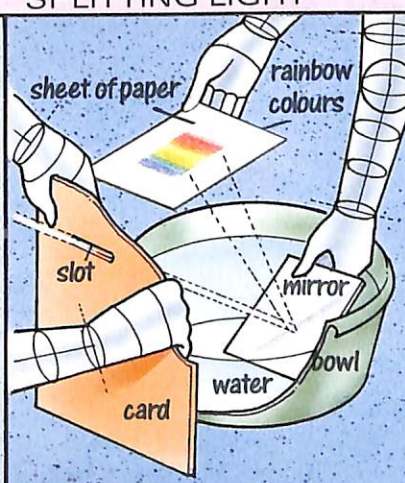
Two nearly identical photographs will be combined by the brain to give the impression of one 3-D image.

Make a support for the camera from two strips of wood as shown. Place it on a firm surface, facing your chosen subject, and take a photograph from each end. For scenes where movement is likely, use two, identical cameras at the same time. Make sure the resulting pictures are printed small, about 5cm x 5cm. Place the photos side by side and look at them through a viewer made from two identical low-powered magnifying glasses as shown.



SPLITTING LIGHT

1 2 3 4 5



When sunlight goes through water it is split up into the seven main colours of the rainbow.

Cut a slot in a sheet of card and place it in front of a window on a very sunny day. Put a bowl of water on a table behind the card; hold a small mirror against one side, a sheet of paper above the bowl, and arrange the sunbeam to fall on the paper.

1 2 3 4 5

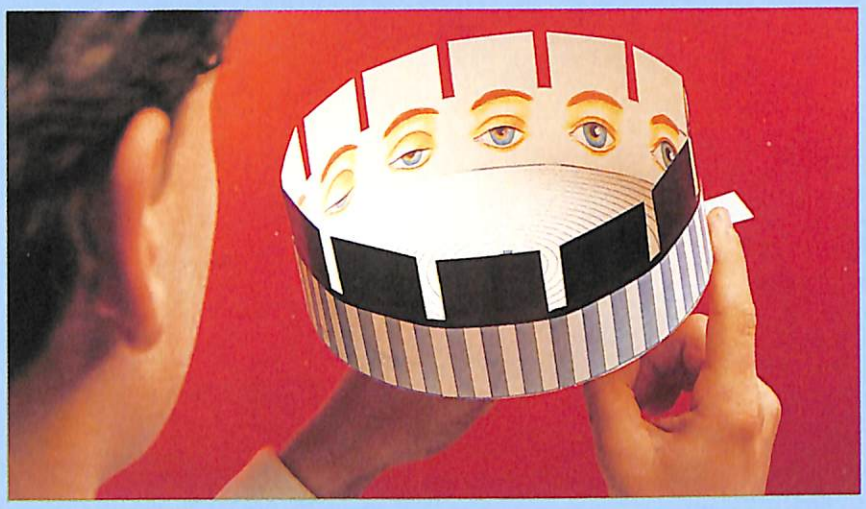
*Each **QUEST** project has been given its own difficulty rating: **1** very simple **2** simple **3** intermediate **4** advanced **5** complicated.*

WARNING!

Every care has been taken to ensure projects are as safe as possible. However, parents should supervise all projects. The publisher can accept no liability for any injury.

MODEL ASSEMBLY INSTRUCTIONS

ZOETROPE



Model Zoetrope

You will need

Scissors • Ruler • Craft knife • Glue

Before cutting out the pieces, score along broken lines with a blunt edge and ruler to make folding and gluing easier. Study the ASSEMBLY DIAGRAM to see how the pieces fit together, and use dotted lines as a guide for positioning.

To make up

Base

1 Cut out base **A**.

2 Cut out base **B**. Cut out centre circle using a craft knife. Place on a flat surface and fold tabs up. Apply glue to tabs facing out, and, sticking one tab at a time, attach base **A** around edge of base **B**.

3 Cut out base **C**. Cut out circle in centre using a craft knife and fold tabs up. Glue in position to inside edge of base **A** (see Fig. 1).

4 Cut out handle **D**. Cut slots where indicated. Roll and glue into a tube and fold flaps down.

5 Cut out bar **E**. Glue in position on flaps across handle **D** (see Fig. 2).

Rotating picture drum

1 Cut out rotating disc **F**. Cut out centre circle using a craft knife.

2 Cut out picture drum **G** and **H**. Glue ends of **G** to ends of **H** to form a drum. Place drum on a flat surface with tabs folded to inside of drum (see Fig. 3).

3 Apply glue to tabs. Place disc **F** inside drum and, pushing handle under rim of drum **G/H**, stick in position on tabs.

To finish

1 Place the completed drum on top of base **B** (with handle underneath).

2 Aligning centre holes, push handle **D** through drum **F** and base **B** until bar rests across centre hole.

How to use

1 Hold the zoetrope by the base handle in one hand so the slots are about level with your eyes. (A pencil pushed up through the tube of the handle will give you a firmer grip.)

2 Use the index finger of your other hand to flick the handle and spin the drum round (see Fig. 4).

3 As the slots whiz past your eyes the eye illustrated inside the drum will appear to be blinking.

Fig.1

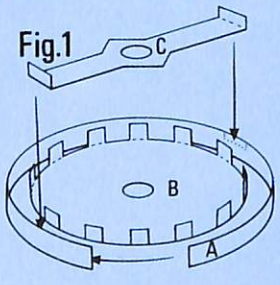
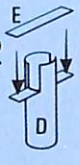


Fig.2



ASSEMBLY DIAGRAM

Fig.3

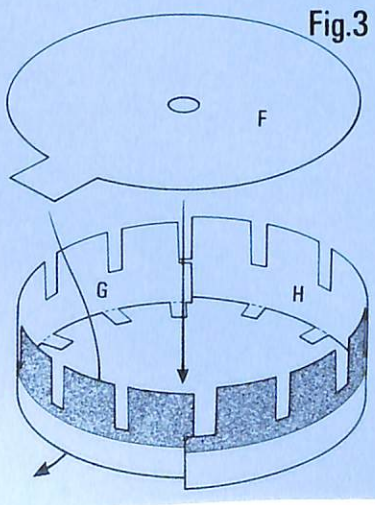
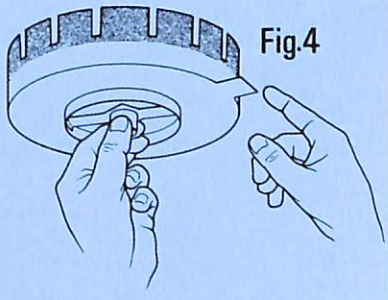


Fig.4



Persistence of vision

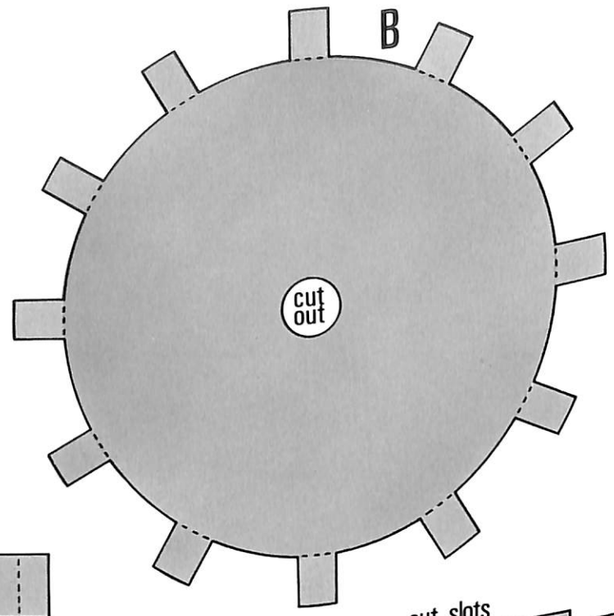
The zoetrope works on the principle of 'persistence of vision' – the eye's ability to retain an image for just a fraction of a second after the image has disappeared.

Each picture inside the drum shows an advancing stage of an eye blinking. As you watch the pictures spin by in quick succession, your eyes experience persistence of vision, causing each image to blend into the next and so creating the illusion of continuous movement.

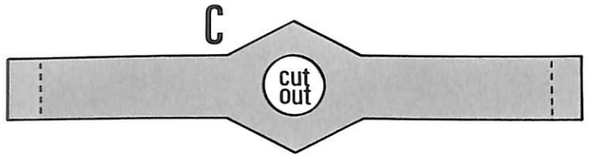
ZOETROPE

An optical picture show

B

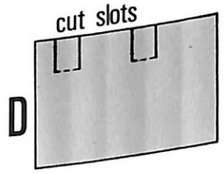


C



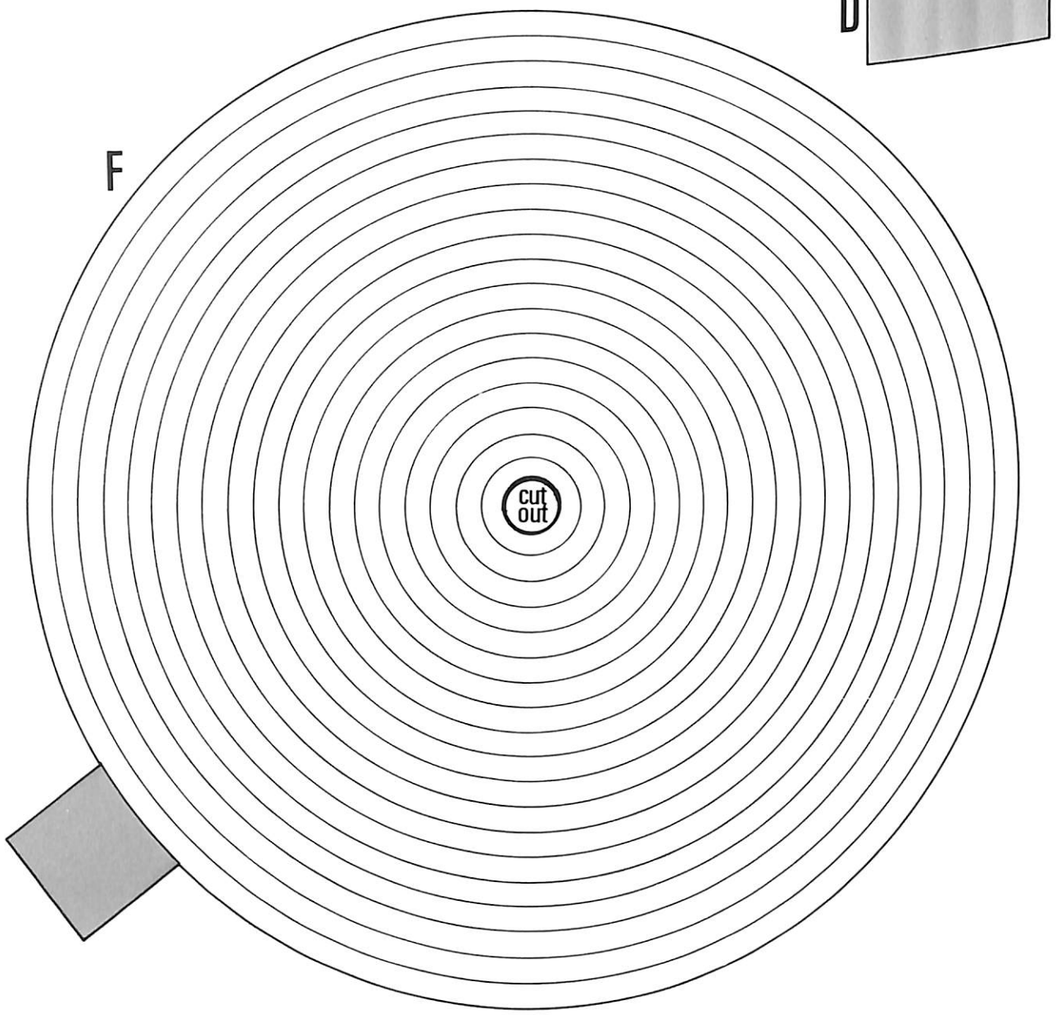
cut slots

D

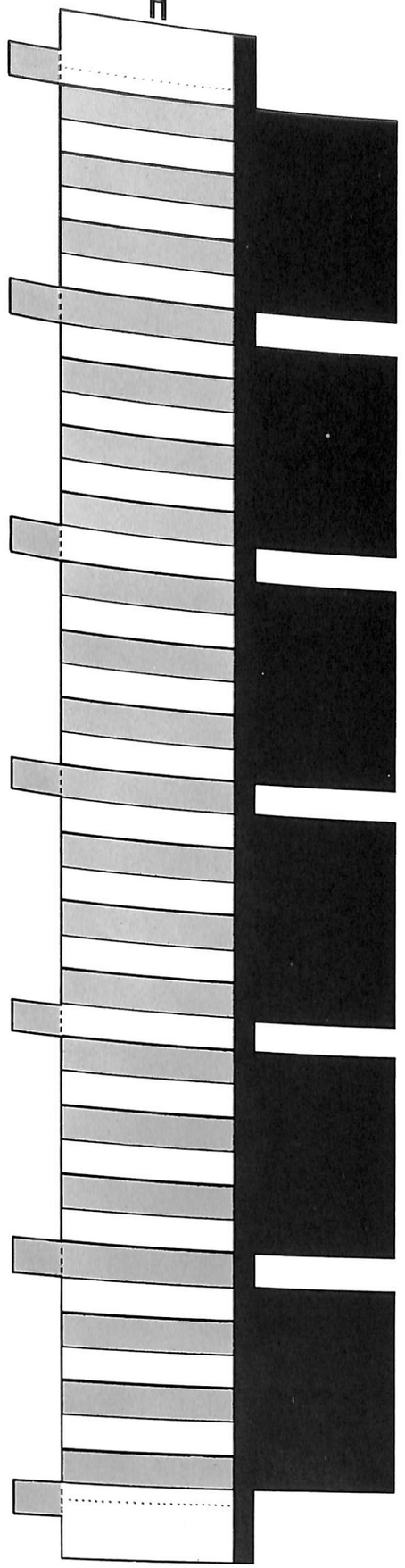


E

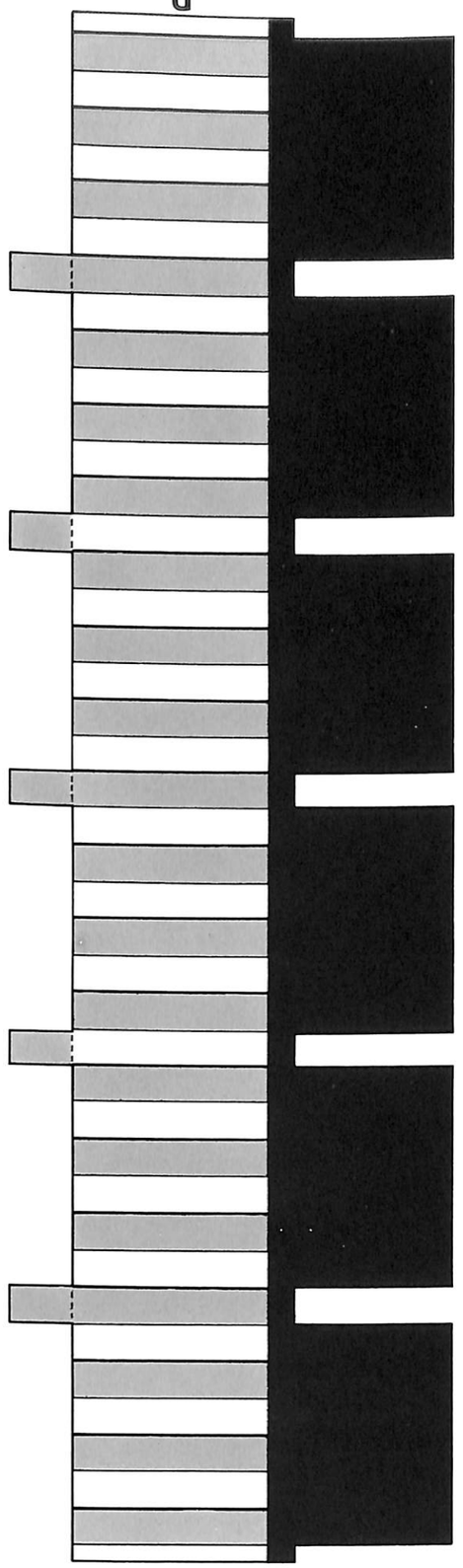
F



H

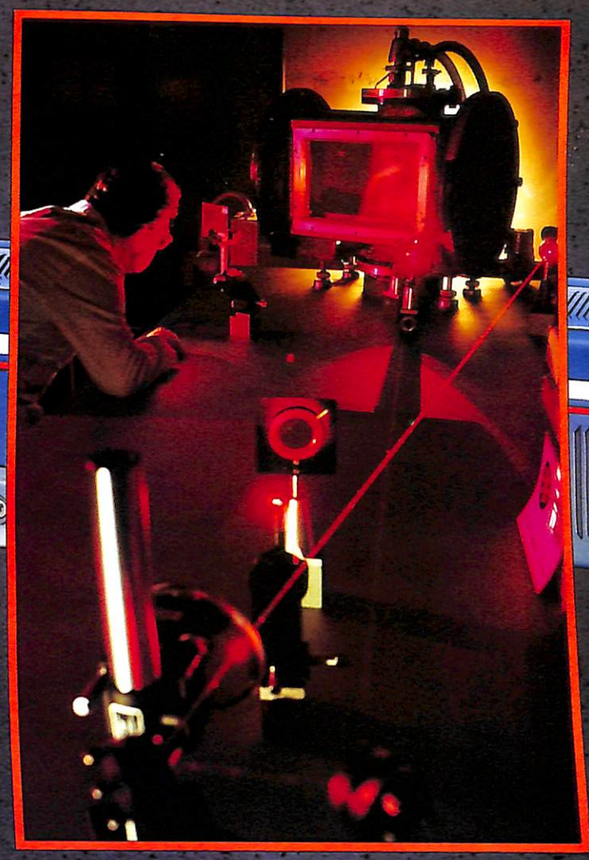


G



A

A hologram is made *in a laboratory. The resulting image can be an exact duplicate of the original object. Even though the original object may be inaccessible, precise measurements can be carried out on the hologram. Dentists, for example, can make measurements on holograms of patients' teeth.*



Philippe Plailly/SPL

beam splitter

laser

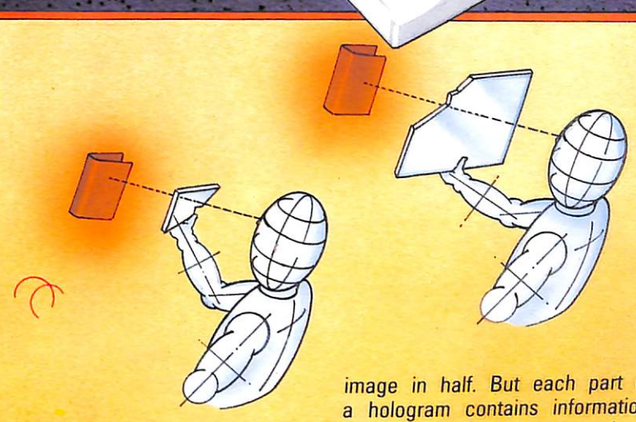
object beam

mirror

object

beam spreader

BREAKING THE HOLOGRAM



Each part of an ordinary photograph contains information about one small part of the object. Cut the photograph in half and you cut the image in half. But each part of a hologram contains information about the whole object as seen from a particular viewpoint. If a piece of the hologram is broken off, the whole object, unchanged in size, can be seen in it, though you may have to change position to see all of it.

STRUCTURES

HOW HOLOGRAMS ARE MADE

QUEST

PICTURES IN 3-D

A hologram is just a flat piece of photographic film – yet when you look at one, the pictured object seems to float in the space behind or in front of it. More amazing still, as you move your head you are able to see around the objects – some things in the scene come into view; others are blocked by objects in front of them.

LASER BEAMS

To make a hologram, light from a laser is split into two parts: the *reference beam* is shone onto the holographic film; the *object beam* illuminates the object and is reflected. Part of this reflected light falls on the film.

BRINGING THE PICTURE TO LIFE

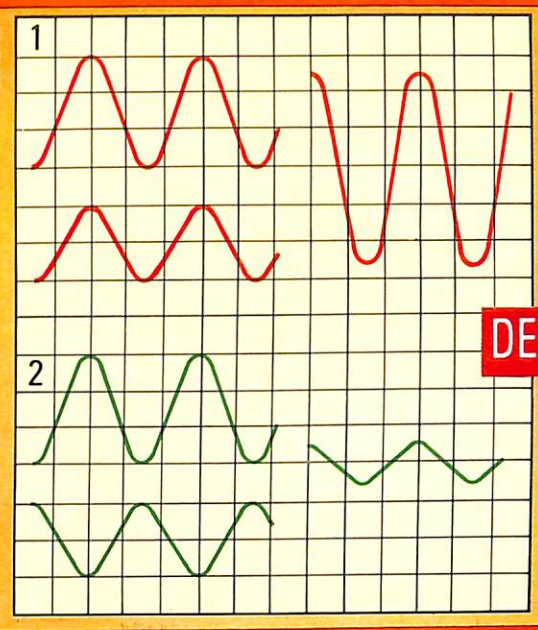
In the photographic film, the object beam and reference beam overlap. When two beams of ordinary light overlap, they produce a brighter beam. But the two beams of laser light produce a pattern of tiny light and dark bands. When the film is developed, the pattern is permanently recorded in the film.

PATTERNS OF LIGHT AND DARK

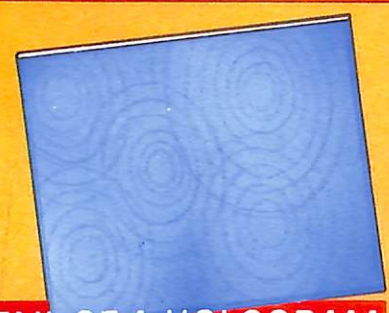
A hologram is best viewed under a strong direct light. Laser light is ideal, but ordinary white light – from a lamp – will do. The pattern of waves in the light reflected from the film is the same as the pattern in the light reflected from the original object. So to someone viewing the hologram, it looks as if the object is right there.

COMBINING LASER BEAMS

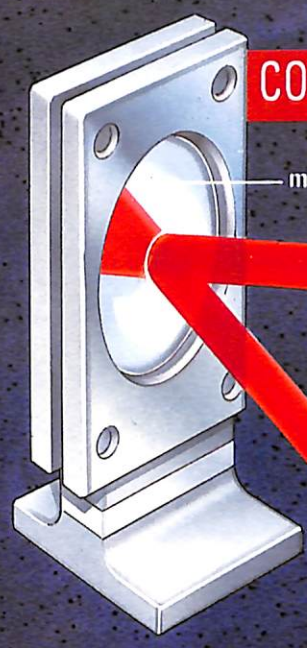
Laser light consists of regular series of waves. When two laser beams overlap, they 'interfere' – they either cancel out or strengthen each other. When the crests of one beam coincide with the crests of the other (1), the beams are 'in phase', and give a brighter beam. If the crests of one beam coincide with the troughs of the other (2), they are 'out of phase' and give a fainter beam.

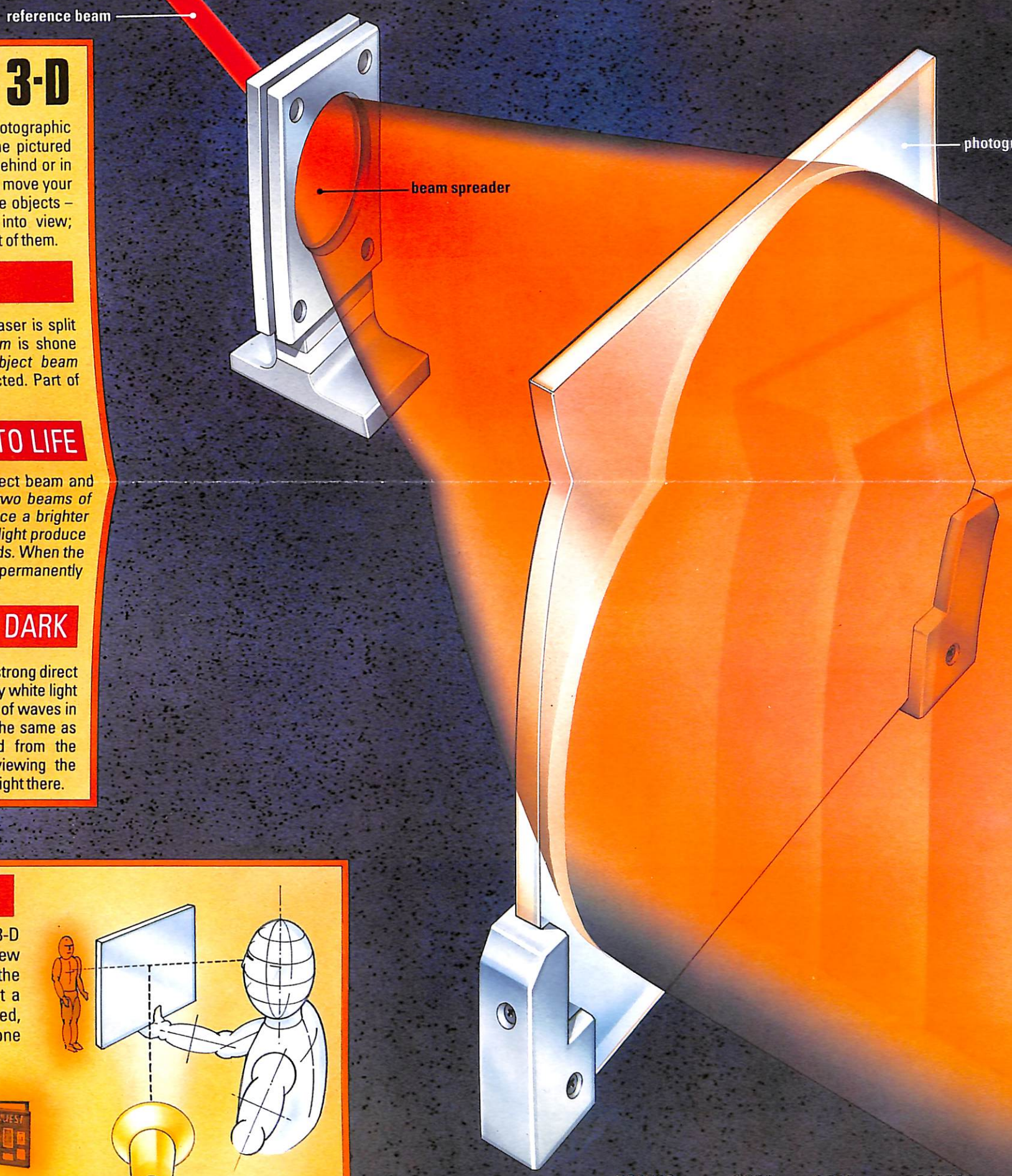


DETAIL OF A HOLOGRAM



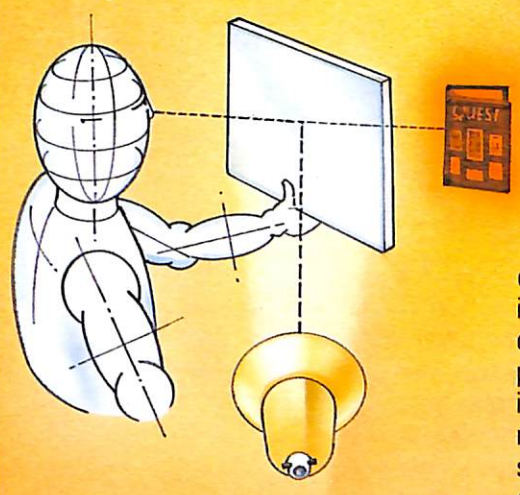
An ultra-close up view of a hologram would show a pattern of light and dark bands. This is the pattern created by the overlapping laser beams used in making the picture. It does not resemble the original object at all.





MULTI-IMAGES

A single hologram can store many 3-D pictures simultaneously. Before each new image is made, the film is rotated so that the reference and object beams strike it at a new angle. When the hologram is viewed, the image that is visible will be the one corresponding to the angle of the light that is illuminating it. If that angle is changed, a different object will become visible to the person viewing the hologram. If a series of images of a moving subject has been recorded, viewing them in quick succession gives an impression of movement. This could be the basis of 3-D motion pictures.



END

Artworks: John Houghton